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CIVIL AERONAUTICS BOARD

AIRCRAFT ACCIDENT REPORT

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UNITED AIR LINES, INC., DC-7, N 6328C, AND
UNITED STATES AIR FORCE F-100F, 56-3755, COLLISION,
NEAR LAS VEGAS, NEVADA, APRIL 21, 1958

SYNOPSIS

On April 21, 1958, about 0830, an Air Force F-100F and a United Air Lines DC-7 collided at 21,000 feet over a position about nine miles southwest of the Las Vegas VOR station. The position was on Victor Airway 8 about 1-3/4 miles to the right (southeast) of the centerline. Both aircraft fell uncontrollable and crashed, killing the 42 passengers and 5 crew members of the DC-7 and the 2 Air Force pilots of the F-100F.

The accident occurred in clear weather conditions while the DC-7 flight, from Los Angeles to New York, was proceeding normally according to an IFR (Instrument Flight Rules) flight plan and clearance, and while the F-100F was executing a simulated jet penetration, part of an instrument training flight which originated at Nellis Air Force Base. The flight was according to a local VFR (Visual Flight Rules) flight plan.

The accident occurred in VFR conditions which, under the Civil Air Regulations, placed responsibility on the pilots of both aircraft to avoid collision through visual separation. This collision was the result of a high rate of near head-on closure at high altitude together with the human and cockpit limitations.

The accident occurred during an Air Force instrument training operation pursuant to Air Force policies which did not take adequate account of human limitations to avoid collision by visual means although the limitations were recognized in other training operations and were known to the Air Force.

The Civil Aeronautics Administration did not take sufficient measures to reduce known collision exposure in visual flight conditions.

Nellis AFB operational personnel, after the accident, took numerous steps which recognize the limitations of visual separation and which will reduce the collision exposure on the airway structure in the Las Vegas area.

The CAA has instigated a program of civil-military coordination, including the review of jet penetrations on a national scale. The goal in this undertaking is also to reduce collision exposure by segregating more effectively high-speed aircraft operations.

It has long been apparent that the possibility of collision increases markedly with very high closure rates of modern high-speed aircraft. Recognizing the limitations of the capability of visual separation by pilots under such circumstances, the Board has embarked on a regulatory program to require a positive control system to the extent that air traffic control facilities will permit. The initial step toward positive control at high altitude has been taken; however, because its implementation is governed by air traffic control capability, the ultimate goal as currently projected is several years away. In the meantime numerous other steps have been taken, or are under study, to ensure a reduction in collision exposure, and of course all parties operating high-speed aircraft must exercise the utmost caution during this interim period.

Investigation

The DC-7. On April 21, at 0737,^{1/} N 6328C, a DC-7 owned by United Air Lines and operated as Flight 736, took off from runway 25L (left) of the Los Angeles International Airport. The flight was a scheduled passenger service from Los Angeles, California, to New York, New York, with intermediate stops at Denver, Colorado; Kansas City, Missouri; and Washington, D. C.

The departure was in accordance with an IFR flight plan which specified Victor Airway 16 to Ontario, California, and Victor Airway 8 to Denver. The flight plan also proposed a cruising altitude of 21,000 feet,^{2/} a true airspeed of 305 knots, and a departure time of 0735. The flight plan remarked that a VFR climb to cruising altitude would be accepted.

The flight crew consisted of Captain Duane M. Ward, First Officer Arlin E. Sommers, Flight Engineer Charles E. Woods, and Stewardesses Pauline M. Murray and Yvonne M. Peterson. Of the 42 passengers 5 were nonrevenue.

Preparations for the flight were routine, and according to the company load manifest the gross takeoff weight of the aircraft was 98,656 pounds, well below the maximum allowable of 106,750. The load was computed to be within the center of gravity limitations.

Following takeoff Flight 736 contacted the Los Angeles departure control on 121.1 mcs. and was given radar vectors during the climb to clear weather conditions above a local haze condition which limited visibility to 2-1/2 miles. Upon reaching the top of the haze layer the flight contacted the Los Angeles Center and received an IFR clearance which was "as filed." The flight was advised to climb in VFR weather conditions to 21,000 feet.

At 0753, Flight 736 reported to Aeronautical Radio, Inc., which serves under contract as the United company radio, that it was over Ontario, at 12,000 feet, and was climbing in VFR conditions. It estimated it would reach Daggett, California, at 0811. Thereafter, at 0811, Flight 736 reported over Daggett. In this report the trip stated it was then at 21,000 and estimated that it would reach Las Vegas (omni range station) at 0831. This was the last position report made by the flight.

^{1/} All times herein are Pacific standard and based on the 24-hour clock.
^{2/} Altitudes, unless otherwise indicated, are mean sea level.

The F-100F. At approximately 0745 that morning F-100F, 56-3755, took off from runway 4 at the Nellis Air Force Base, Las Vegas, Nevada. The flight was an instrument training flight with Instructor Pilot Captain T. N. Coryell occupying the front seat of the 2-place aircraft and Trainee Pilot First Lt. J. D. Moran in the rear cockpit seat.

Preparation for the flight was routine. A preflight briefing was conducted by Captain Coryell during which the mission was reviewed. The flight was in accordance with a VFR local flight plan filed with Nellis Operations and the local traffic control tower. According to the flight plan it was proposed that the training mission would last 1 hour, 25 minutes, and that the fuel load was sufficient for about 1 hour, 50 minutes.

At approximately 0823 Air Force 755 called "Nellis VFR Control" and reported that it was "inbound on KRAM" (a local commercial radio broadcast station). The flight requested an altitude assignment from which it would conduct a simulated ADF instrument jet penetration utilizing KRAM. The VFR controller assigned 755, 28,000 feet and advised it to report over the radio station. At approximately 0828, 5 minutes later, the flight reported that it was over KRAM requesting a penetration. The VFR controller cleared Air Force 755 for an immediate penetration and requested that it report the penetration turn. Air Force 755 then reported leaving 28,000 feet. There were no other reports from the flight in connection with this procedure.

Weather conditions in the Las Vegas area at the time of the accident were clear with visibility more than 35 miles. Winds at 21,000 feet were from 300 degrees at 45 knots.

At 0830 the offices of Aeronautical Radio at Los Angeles, Denver, and Salt Lake City heard an emergency message from the United flight. The message was interpreted as "United 736, Mayday, midair collision, over Las Vegas." This message was recorded on equipment which permits a determination of the exact time of the message. By replaying the recording and timing it, it was learned that the message began at 0830 plus 20 seconds.

At the same time, as nearly as can be determined, there was an unrecorded emergency transmission from the F-100F. This message was heard by the VFR controller and by the two pilots of another F-100F. All were agreed that the first portion of the emergency transmission was "Mayday, Mayday, this is 755." The last part of the message was either "We've had a flameout" or "We're bailing out." All of the persons who heard the transmission believed the message could have either interpretation. Since it was unrecorded no further determination can be made from this source.

A committee of investigators contacted 140 persons who were reported to have seen some portion of the accident. Of these persons, 49 gave statements describing their observations. A study of these statements indicated that only two youngsters, ages 13 and 8, saw the aircraft before they collided. Their observations, when compared with structural and operational evidence, proved quite accurate. Their observations indicated the aircraft approached each other quartering head-on, with the DC-7 flying northeasterly and the F-100F flying southerly or southeasterly. They indicated that a few seconds before impact and while the DC-7 flew straight and level the F-100F rolled in an

obvious attempt to avoid the DC-7. The direction of roll was in dispute. At the instant of contact a third witness saw the aircraft and described them as nose-to-tail, on northerly and southerly headings, and with the F-100F banked steeply. The three witnesses said a wing of each aircraft made contact although they could not tell which. They stated there was a puff of smoke, a flash of fire, and a shower of metal pieces indicating the collision.

Following the collision numerous witnesses saw the DC-7 "stagger" straight ahead, then descend in a right turn which became a steep spiral or spin. After one or two turns the engines of the DC-7 tore out accompanied by a flash of fire. It is believed several witnesses who saw this thought it was the collision. After several turns the aircraft struck the ground and exploded.

The F-100F was described as having proceeded on a southerly heading with white or gray smoke marking its arc to the ground. The F-100F fall was described as a very steep descent during which one or two witnesses thought that the aircraft rolled about the longitudinal axis. Of the persons who noted both aircraft nearly all agreed the F-100F crashed much sooner than the DC-7 and that it also exploded on impact.

All of the witnesses stated that the weather conditions were clear with no clouds in the sky and that the visibility was very good.

From the locations of several heavier pieces of wreckage and in consideration of wind drift during their descent, the probable position over which the collision occurred was determined as nine miles southwest of the Las Vegas VOR station (located on McCarran Airport). This position was on Victor Airway 8, about 1-3/4 miles southeast of its centerline.

The main portion of the DC-7 wreckage was located approximately 2.6 miles northeast of the estimated collision position. Investigation revealed that the aircraft was in a relatively flat attitude at ground impact with a high sink velocity relative to its forward motion. On impact it broke into numerous pieces along a heading of 160 degrees. The wide separation between the ground marks made by each powerplant confirmed observations of eyewitnesses who stated that they separated in flight. Similarly, the wide distribution of many major wreckage pieces showed that a general disintegration of the aircraft occurred before the ground impact. Examination of the pieces of structure provided clear evidence that the inflight breakup of the aircraft after collision resulted from airloads which exceeded the design strength of the structure. There was no indication of structural failure prior to the collision.

The F-100F main wreckage site was located 5.4 miles south-southwest of the DC-7 site. The aircraft had contacted the ground on a northerly heading and, similar to the DC-7, it struck the ground in a relatively flat attitude with extremely high sink velocity as compared to forward motion. The impact, and fire which followed, caused major destruction of the structure. As near as could be determined from the evidence, at ground impact the landing gear and flaps were up and the speed brakes were closed. There was no evidence to indicate structural failure of the F-100F prior to the inflight collision.

During the investigation every effort was expended to determine, independent of eyewitness information, if there had been a midair collision and, if so, the manner in which it occurred. In doing this, much of the wreckage was

documented as to location and identification. Thereafter most of the structural wreckage was removed from the scene to a location on Nellis Air Force Base where certain areas from both aircraft were reconstructed and minutely examined.

Most important to these objectives were the right outboard wing sections of both aircraft and the right horizontal tail of the F-100F. These components were widely separated from the main wreckage areas and bore clear evidence of inflight contact which separated the wing sections as a result of and at the time of the collision. Examination showed these components were the only major ones directly involved in the inflight contact sequence.

The DC-7 wing section was found 2.5 miles southwest of the DC-7 main wreckage. The F-100F right wing section, a heavier piece somewhat less subject to wind drift, was found 1,200 feet west of the DC-7 wing section and it was about 3.3 miles northwest of the F-100F main wreckage.

There were two swaths cut in the DC-7 wing section, one which severed the piece and one which penetrated to approximately the front spar on the upper wing surface and to approximately the center spar on the lower wing surface. The major swath penetrated the DC-7 wing at station 580 at the leading edge of the wing and progressed irregularly through the wing chordwise to the trailing edge of the aileron. The exit of the swath was wing station 635. Measured along the leading edge the section of DC-7 wing which was severed was about 12 feet in length. The average angle of this major swath was approximately 34 degrees measured from a chordline through the right wing or 34 degrees to the longitudinal axis of the aircraft. As shown by wing station locations the cut therefore extended diagonally outboard and aft from the leading edge, through the wing, to the trailing edge of the DC-7 right wing.

The major swath was 24 inches wide. The structure within this area was shattered into small pieces, many of which were not recovered. However, those pieces which were found were located with wing sections and below the collision point.

Examination of the inboard and outboard edges of the major cut, especially in the area where lighter structural material is used in the DC-7 wing construction, showed clearly that the object which cut moved slightly downward relative to the DC-7 wing. It was also revealed that edges of the swath on the lower wing surface were almost precisely below the corresponding edges of the swath on the upper wing surface. This showed clearly that the cutting plane which made the cut was nearly perpendicular to the DC-7 wing plan form.

The second cut in the DC-7 wing was located between stations 511 and 503. It was essentially parallel to the major swath and was about eight inches wide. As previously mentioned, this cut extended rearward to the front spar on the upper wing surface and to the center spar on the lower wing surface, indicating heavier structure was cutting the lower wing surface of the DC-7 wing. The effect of the two swaths was to cut out a section of leading edge of the DC-7 wing about three feet in length between wing stations 509 and 543 at the leading edge and between wing stations 525 and 557 at the front spar. The relatively short depth of the second swath showed the cutting object was destroyed before it could cut through the entire wing. The upper wing skin behind the cut and in

line with it or the area aft of the center spar at about station 528 was marked by a deep cut and related deep scratches running aft and outboard in line with scratches found on the aileron.

The wing section severed from the F-100F measured approximately 12 feet. The swath through this right wing was irregular; however, the average angle of the swath was 12 degrees relative to the longitudinal axis of the aircraft. The inboard edge of the cut was 132 inches from the fuselage centerline at the wing leading edge and was 86 inches from the fuselage centerline at the wing trailing edge. Thus, the swath ran aft and inboard through the F-100F wing panel.

The width of this cut was about 16 inches. The structure within this area was shattered, some of which was found below the collision location. One piece from this area was found loose inside the severed wing section of the DC-7.

The right horizontal tail of the F-100F was broken off 86 inches from the centerline of the aircraft. The outboard portion was not recovered. Investigation showed that a line drawn through the wing swath of the F-100F at the angle of 12 degrees previously shown passed through the horizontal tail at the fracture line. This clearly showed that the object which cut through the wing panel of the F-100F also contacted and tore off the severed portion of the right horizontal tail of the jet airplane.

The DC-7 powerplants were recovered about one-half mile northeast of the DC-7 wreckage. They were removed from the desert area to a suitable area for a more detailed examination. Each powerplant had been torn free from the DC-7 with most of the nacelle attached. Evidence indicated the nacelle structure failed from excess loads. However, there was insufficient evidence to indicate the manner in which failures occurred. Each powerplant struck the ground in a similar manner as evidenced by impact damage to each unit on the right side. The accessory case was broken from each powercase.

The engines were partially disassembled to examine their interiors. This disclosed that remaining gear trains, bearings, and other moving parts had been normally lubricated. The articulating assemblies showed no evidence of operating distress and the examination of the oil pumps and screens showed they were free of foreign materials.

Several engine accessories were recovered. However, impact and fire damage precluded them from being functionally checked.

Each DC-7 propeller remained attached to its engine and each was found to be tight on its propeller shaft. Although impact damage made it impossible to obtain the propeller dome settings it was possible to determine readings of the propeller blade angles from impact marks on the shim plates. It was learned from this work that all of the propellers were operating at blade angles within the cruising range. This is considered a clear indication of normal inflight operation of the engines and propellers until the powerplants separated from the aircraft.

The jet engine, a Pratt & Whitney J-57-P-21A, was with the main wreckage of the F-100F but had torn free of the fuselage structure. It was badly damaged

by ground impact, the attendant explosion, and subsequent ground fire. It was removed and transported to the Nellis Air Force Base engine overhaul hangar where it was completely disassembled. Because of the conflicting interpretations of the final radio transmission from the aircraft, every effort was expended to determine if there had been an inflight malfunction or failure of the powerplant prior to impact which would have caused it to "flame out." Examination of the compressors, combustion section, turbines, and all bearings revealed no evidence of malfunction or failure prior to ground impact. In fact, from the clear rotational indications shown on the stator, compressor, and turbine blades highly experienced personnel estimated that the engine was operating in excess of 80% power at ground impact. From this evidence it was concluded that the final transmission from the crew must have been "We're bailing out" and that the flight had not experienced a "flameout."

Nellis Air Force Base is located about six miles northeast of Las Vegas. It is below Victor Airway 8 and within its lateral confines. At the time of the accident its principal mission was the training of recently graduated Air Force pilots as "combat ready" in the F-100 aircraft, a supersonic fighter. Actual instrument approaches to Nellis are controlled by McCarran approach control and there are no radar facilities such as RAPCON (Radar Approach Control) or GCA (Ground Controlled Approach) serving the Base.

The flight curriculum followed is established by Air Force and Air Training Command regulations and consists of about 35 flight hours, supplemented by intensive associated ground training. The flight curriculum includes air combat maneuvering, formation, gunnery, and instrument phases.

Flying training at the Base was conducted in VFR weather conditions only and, at the time of the accident, in accordance with local VFR flight plans. Normal activity at the Base on a training day was between 500 and 800 aircraft movements (takeoffs and landings), of which about 400 were attributable to the training function.

Individual missions were flown within a local flying area, roughly 125 miles square, and principally that area north, east, and west of the Base. The local flying was established in accordance with Air Force Regulation 55-19 and is a common requirement for all Air Force Bases.

Generally, the trainee pilots were Second Lieutenants with about 330 to 360 flying hours. They were jet qualified and held instrument ratings issued by the Air Force.

The flight phases are supervised by instructor pilots at squadron level. These pilots are highly qualified personnel selected according to Air Force directives and then trained for the work. Through an impressively rigid standardization program at all echelons the instructors are supervised and the training program is standardized. Instructor pilots supervise all training missions and, with the exception of three "solo transition flights," accompany and lead the flights.

As indicated, instrument training is one of the phases of the curriculum. Normally it is accomplished after the trainee has about 15 hours in the F-100

and has become familiar with the aircraft. This phase is designed to teach the student instrument flying in this particular aircraft since he is already instrument qualified in jet aircraft and holds an instrument rating issued by the Air Force. Instrument missions are flown in the F-100F, which is the 2-place version of the F-100. It was stated that during this training the instructor pilot occupies the front cockpit and is responsible for the safety of the flight including the separation from other flights in visual conditions as required in the existing Civil Air Regulations. The student pilot occupies the rear cockpit seat and while the training is being conducted is precluded from outside vision by a hood designed to pull over the entire rear cockpit along the canopy above the student pilot's head. The vision of the instructor pilot is not obstructed by the hood.

At the time of the accident the flying phases, excepting part of the instrument work, were done off airways in subdivisions of the local flying area. Careful consideration was given in this regard and many precautions were taken to keep the flights off airways or when crossing airways to maintain straight and level flight. Basic instrument flying was kept within the transition and formation subdivisions.

At the time of the accident that portion of instrument flying which involved the use of navigational aids such as holding, tracking, and jet penetrations, was practiced within a designated area with a radius of 25 miles centered on Nellis AFB. This area included the intersection of several airways in the Las Vegas terminal area and it was mostly within the confines of the airway structure. Within this area all jet penetrations were practiced.

Air Force Regulation 55-19 governing the control of simulated instrument approaches states in part, "The commander will direct maximum use of outlying facilities in order to relieve air traffic congestion near local navigational facilities." The regulation also states, "Air Force Air Traffic Control Personnel who are not authorized to provide IFR control service will furnish traffic information to those pilots practicing instrument approaches and advise them to maintain VFR flight."

It was stated, with respect to AFR 55-19 and its provision to establish penetration on outlying facilities to relieve air traffic congestion near local facilities, that within the range capabilities of the F-100 there were no facilities suitable for the penetration other than those at Las Vegas. Also, it was most desirable to establish the penetrations near the base because they are performed at the end of a training flight when fuel is limited and the latter portion of the penetration is at low altitude when fuel consumption is highest. For these reasons, as well as the installation and maintenance costs, the establishment of outlying facilities was considered undesirable.

Nellis instrument training procedures required that before a flight entered the 25-mile instrument practice area the pilot must secure a clearance and altitude assignment. This was accomplished through "Nellis VFR Control" which simulates an approach control. VFR control was incorporated to relieve the workload of the control tower, to provide separation between Nellis aircraft, and to give the trainee pilots practice in radio procedures. The VFR controller normally gave altitude assignments, 19,000 feet or higher, with 1,000 feet vertical separation.

Testimony of Air Force personnel stated that the VFR control did not perform an air traffic control function except for Nellis aircraft and its use did not relieve the instructor pilot of visual separation responsibilities required of all pilots by Part 60 of the Civil Air Regulations, restated in Air Force Regulation 60-16 in equal or stricter requirements. It was stated that the VFR controller did not have knowledge of any air traffic other than the Nellis instrument training flights described. There were no procedures to alert the jets of other traffic known to Air Traffic Control. It was stated that such advisory service was beyond the capability of the Base and ATC facilities.

Investigation revealed that at the time of the accident seven jet penetrations were used for the Nellis AFB. Three were published in the USAF Pilot's Handbook and the other four were unpublished procedures. Although all seven procedures were formulated according to standard criteria for instrument approaches the latter four were approved through a local letter of agreement dated May 10, 1957, entered into between the Base and the Civil Aeronautics Administration. The KRAM penetration was one of the unpublished procedures and, as shown, was being flown when the collision occurred. A review of the specified penetration track showed that it was nearly all within the lateral limits of Victor Airway 8. It was estimated by Air Force personnel that this procedure and the others were flown by all aircraft, training or otherwise, 40-60 times daily.

For the KRAM penetration procedure, according to qualified witnesses, the pilot would obtain permission to enter the instrument area and receive an altitude assignment. The flight should then "track in" on the commercial broadcast station. This inbound track would be one which requires less than a 45-degree turn to the penetration heading of 170 degrees after passing over the radio facility. If the inbound track required a greater than 45-degree turn, a right turn to intercept the outbound track was necessary. According to the established training procedures the speed of the aircraft should be 300 knots indicated airspeed. After overheading the radio station approval for the penetration is obtained with permission to leave the assigned altitude. When approved, the pilot should report leaving the altitude. At this time the "speed brakes" of the F-100 are extended and a descent is established holding 300 knots indicated airspeed. If necessary and when the ADF indications are stable, the pilot is expected to correct to a 170-degree outbound track from KRAM. Normally the descent is continued until one-half of the initial altitude plus 3,000 feet has been reached, in this instance 17,000 feet. At this altitude a right penetration turn is required to a heading of 35 degrees. The descent is continued throughout the turn and until a minimum altitude is reached on the 35-degree heading. The aircraft is again turned, if necessary, to establish a 35-degree inbound track to the runways at Nellis Air Force Base. At the proper time, and if remaining fuel permits, the penetration is followed by a simulated missed-approach procedure and/or another penetration.

The Assistant Director of Air Traffic Control of the Civil Aeronautics Administration testified, in essence, that the penetrations were established according to the U. S. Manual of Criteria for Standard Instrument Approach Procedures, pursuant to Civil Air Regulations Part 60 (60.46). He stated that the principal considerations required were to establish a procedure which would be expeditious and safe as an instrument approach in instrument weather conditions.

He stated that the agreement of May 10 was considered in this light and, because Air Traffic Control separates air traffic in instrument weather conditions, publication and dissemination of the procedures was confined to those controlling and performing the procedures. The agreement was therefore coordinated with the Salt Lake Control Center, McCarran, Tower, and Nellis AFB personnel. Certain divisions of the CAA received copies of the agreement for review or comment but these functions did not contemplate dissemination to other users of the airspace.

The Assistant Director testified that it was known to CAA that the procedures would be used extensively during VFR weather conditions for practice purposes. On such occasions, he stated, the penetrations were VFR procedures and rules governing visual separation applied. In this light dissemination of the agreement was unnecessary and would be of little value. In essence, he stated that prior to the accident extensive use of the jet penetrations in VFR weather conditions by high performance fighters was not a principal factor for consideration in formulating and/or approving such procedures. He stated also that the CAA was well aware that there were limitations to visual separation resulting from high speed and that the jet penetrations involved flight on airways where much of the air traffic, especially air carrier, was operating.

With respect to the use of advisory service which would alert known (IFR) traffic to instrument flights in the Nellis instrument area, the Assistant Director indicated that for such information to be of value it must be detailed, timely, and accurate when given. The witness indicated that such service was equivalent to IFR control. He said that this type of service had been studied and attempted; however, it so deteriorated normal IFR service the project was discontinued.

The Wing Operations Officer for the Nellis Training Wing stated, in response to questions at the public hearing, that he knew of no NOTAM which announced to other users of the airspace that extensive training was being conducted in the Las Vegas area. He stated, however, that on May 27, 1957, the Base had made application for certain off-airway areas within the Nellis local flying area to be designated "Caution Areas." This application, to his best knowledge, was, at the time of the hearing, on a "hold status" before the Washington Airspace Panel. Investigation has since revealed that the application was considered by the Airspace Panel on October 22, 1957, and was deferred at the request of the CAA until CAA could review the general policy relating to the present definition of "caution area" and the compatibility of such areas with the Continental Control Area (above 24,000 feet) and high altitude jet routes. Pending formal disposition, on June 10, 1958, all proposed caution areas were published in the Airman's Guide as "Military Training Areas" for the information of all concerned. The witness further added that he personally had given a talk before the Aviation Committee of the Las Vegas Chamber of Commerce concerning the Nellis AFB training function and had distributed photographs showing the Nellis local flying area. (Minutes of the Meeting showed a United Air Lines agent in attendance.) The Minutes revealed that he informed the committee there would be 250-300 aircraft flying from the Base each day. The Operations Officer also said at the meeting that there was a need for the caution areas because speeds of the training planes made collision avoidance by visual means very difficult. At the public hearing the witness stated that he did not recall specific mention of the instrument area or the

penetration procedures but that a photograph was distributed during his talk which showed the instrument area as it was located at the time of the accident. It was also noted that there was a caution area (C-436) located northwest of the Base, published on aeronautical charts. Legend indicated "Heavy aerial traffic" effective "Unlimited" and time "Continuous." The witness pointed out that the base had been ready and willing to furnish reasonable information concerning the training activity but to his knowledge none had been sought.

With reference to the accident the Wing Operations Officer said that jet penetrations were flown on the airway structure because the facilities necessary in executing them were there. He felt, for the reasons already stated, it was impractical to perform them elsewhere or establish the aids elsewhere for practice purposes. He said that civil airways are open to all users and in his mind penetrations were not unusual or hazardous. He felt the F-100F flight was in compliance with Civil Air Regulations in all respects.

On the recommendation of the Air Force, an Air Force officer, who was an expert in the field of aerophysics, testified concerning the effectiveness of visual separation by pilots. Based on the circumstances surrounding this accident, he calculated the probabilities of visual detection by the pilot (s) of these airplanes over various ranges.

His conclusions substantiated the testimony presented by the Board's staff that the probability of collision increases markedly with the high closure rates of modern high-speed aircraft. The witness's calculations were based on theoretical concepts developed some years ago by the Department of the Navy. He indicated that, although the results of his work in regard to this accident were not known to the Air Force, similar studies and results were well known.

The manager of United Air Lines flight operations stated that United pilots are instructed to plan their flights on airways, including the 1500 series, and on authorized high-altitude off-airways routes. Below 18,000 feet and in controlled airspace the pilots are permitted to plan a flight and file it according to a VFR or an IFR flight plan unless weather conditions permit only an IFR flight. Above 18,000 feet the flight must be planned and flown according to an IFR flight plan although VFR restrictions may be requested during climb and/or descent and when necessary. A flight over a high-altitude off-airways route must adhere to visual flight rules and only an IFR flight plan may be filed.

The witness said that the planning and operating of a flight above 18,000 feet according to IFR regardless of weather was to obtain as much air traffic control separation as possible. The witness stated that United understood that Civil Air Regulations and Air Traffic Control procedures did not preclude VFR flights in controlled airspace and during VFR weather conditions VFR and IFR flights would be intermixed. He said it was clear that in VFR weather an IFR flight received separation only from other like flights. Because of this, he said, it was United policy to require continued pilot vigilance for other traffic in VFR weather and, according to Civil Air Regulations, it was the pilot's responsibility to maintain visual separation regardless of flight plan or clearance. The witness furnished United company material and operation procedures reflecting this policy and said that cockpit vigilance was a subject of continuing emphasis.

The flight operations manager stated that certainly the location of Nellis AFB was known to United Air Lines personnel. He stated that operations personnel also knew it was a training base from which "Century Series" fighters were being operated. He indicated that this was all too well known from "near miss" incidents on the airways in the Las Vegas area which had occurred for more than a year. He did not know the number of such incidents but stated they were "numerous." The witness said that these incidents had been reported to the CAA both by telephone and correspondence. The witness stated it was his understanding that Nellis and CAA personnel had discussions about the incidents but he felt no corrective action resulted although he did not know.

The witness said that United Air Lines personnel had not gone to Nellis seeking consultation on the matter. He said that in the mind of United, the responsibility for the administration of the Civil Air Regulations belonged to the CAA. Consequently, all communications regarding the occurrences, which he believed were violations of the Air Traffic Rules, were directed to the CAA for appropriate action.

In regard to the jet penetrations, the flight manager stated the company did not have knowledge of them. He said United had not been furnished information on the penetrations, resulting from the Nellis-CAA agreement, although he believed such information was most desirable and should have been given other users of the airspace. He indicated that while it may have been reasonable to expect that approach procedures would be flown during the Base training program he did not know penetrations such as KRAM were being flown. The operations manager said that he did not think it was reasonable to expect that high-speed jet penetrations were being flown under uncontrolled conditions, as far as Air Traffic Control was concerned, in the center of a highly traveled airway such as Victor 8. The witness said that had United been informed of the penetrations he thought the company would have taken steps to alleviate the condition. The witness also added, in response to questions, that United personnel had not asked Nellis personnel for information concerning the operation or the extent of it from the Base.

The United representative, who was in attendance during the Chamber of Commerce meeting when the Nellis Wing Operations Officer spoke, stated that he had received a copy of the photograph distributed. This, he said, was forwarded to the office of the United operations manager in Los Angeles. The operations manager did not recall receiving the photograph and had no knowledge of its disposition.

Witnesses from the Board's regulatory staff testified that under the Civil Aeronautics Act of 1938, as amended, the Board is charged with the responsibility of prescribing rules for the regulation of air traffic. In Title I, Section 2, of the Act, the Congressional intent is set forth by which the Board is guided in this responsibility. It requires, "The regulation of air commerce in such manner as to best promote its development and safety"; and, "The encouragement and development of civil aeronautics." The Act also states that full consideration shall be given to the requirements of national defense. It states further that "There is hereby recognized and declared to exist in behalf of any citizen of the United States a public right of freedom of transit in air commerce through the navigable air space of the United States."

It was further stated that from its Congressional mandate it is very clear that the CAB obligations in rule making are not only to ensure adequate separation of traffic but also to avoid unnecessary and crippling restrictions. Thus, the presently existing Civil Air Regulations and air traffic control concepts have intended to fulfill these obligations, and have intended to promote aviation in all of its segments, private, commercial, and military. The Board has contemplated in its rules that all users, small and large, be permitted to operate in air commerce as freely and economically as possible, consistent with air safety.

The witness pointed out that it is true that in some instances the freedom from crippling restrictions and the free and expeditious flow of traffic by all users may conflict. The Board has therefore sought to develop rules which best serve the public interest. It is equally evident that Air Traffic Rules must consider the capacity of the existing air traffic control system which is a responsibility of the Civil Aeronautics Administration.

The existing Air Traffic Rules and control concepts, it was stated, classify all air traffic into two broad categories, Visual Flight Rules and Instrument Flight Rules. In the first category it is assumed that pilots are able to see and avoid other traffic, and in the latter it is assumed that weather conditions preclude them from carrying out this responsibility. Civil Air Regulations clearly define the weather conditions which permit or require VFR and IFR operations.

In VFR weather conditions it is permissible, under the regulations, for a flight to be conducted according to instrument rules. Thus, in the same navigable airspace there is an intermixing of IFR and VFR traffic when visual weather conditions exist. In such a situation Air Traffic Control will provide separation between IFR flights; however, because VFR flights may be operating in the same airspace unknown to Air Traffic Control the pilots must adhere to the "see and be seen" philosophy. In visual flight conditions it is therefore the pilot's responsibility to see and avoid other aircraft regardless of flight plan or clearance. Under the air traffic rules, all operators are on notice that pilot vigilance adequate to ensure separation at all times is a condition operative upon every flight in VFR weather conditions. Any operation which compromises this intent should provide additional safeguards to ensure that other users are not endangered.

Personnel of the Board's staff testified that the Board was well aware of the fact that visual flight rules are not a complete guarantee against midair collisions. In fact, in the last 10 years there has been a total of 159 midair collisions involving civil aircraft, almost all of which occurred in VFR weather conditions. It has long been apparent, moreover, that probability of collision increases markedly with the very high closure rates of modern high speed aircraft such as the "Century Series" jet fighters and that, at the highest of such speeds, margin for collision avoidance by visual means is non-existent. However, determination of the particular closure rate at which pilot capability to see and avoid other aircraft has disappeared or is reduced to an intolerable level is a judgment concerning which considerable difference exists. This is a problem which is now undergoing intensive investigation and study by the Board in an effort to reach more definite conclusions. Meanwhile, the Board has determined that the Civil Air Regulations should continue to make provision for visual flight operations with whatever refinements are practicable to reduce exposure to collision.

The Civil Air Regulations are given wide distribution among all who fly and knowledge concerning their contents is required as a condition of airman certification. Moreover, the Board's rule-making processes ensure that a interested persons are given full opportunity to participate in the making of regulations. All major segments of aviation do in fact participate by personal representation or in writing. The visual flight rules have been developed and maintained through such processes. All major segments of aviation have been in agreement, and to the Board's knowledge, are still in agreement, that the limited capabilities of the air traffic control system prevent a complete alternative at this time.

Personnel of the Board's regulatory staff testified that the responsibility for the approval of instrument approach procedures was delegated to the Administrator in Civil Air Regulations Part 60 (60.46). Testimony indicated that because this regulation is part of the instrument rules it was not required to consider VFR use of the procedure as a factor in the approval. In essence, it was stated that sufficiency of the procedure for use under IFR was the only required consideration.

Analysis

The three principal areas of collision damage and related marking furnished the foundation for the Board to make a reasonable determination of the inflight collision sequence. This, together with operational and eyewitness information, also enabled reasonable deductions as to the flight paths of the aircraft as they approached collision.

The analysis indicated that initial contact occurred between the leading edge of the DC-7 right wing at station 574 and the leading edge of the F-100F right wing 132 inches outboard of the aircraft centerline. The two wings progressively penetrated one another until the outboard portion of each was severed; in the case of the DC-7 the wing was severed along a swath line 34 degrees aft and outboard, and in the instance of the F-100F along a swath line 12 degrees aft and inboard. A second cut in the DC-7 wing, located about 24 inches inboard of the first, was made by the right horizontal tail of the F-100F which penetrated rearward until the cutting object, the outboard portion of the tail, was destroyed. This entire collision sequence occurred in less than 1/100 of a second.

A vector diagram, using the 34-degree fracture line in the DC-7 wing, estimated true airspeeds of the DC-7 and F-100F of 312 and 444 knots, respectively, and assuming a small angle of descent for the F-100F, indicated that at impact the aircraft were on quartering head-on courses about 122 degrees apart with a closure speed of about 665 knots. Believing the DC-7 was flying a magnetic heading to follow Victor Airway 8 and was in nearly straight and level flight, at collision the heading of the DC-7 was 23 degrees magnetic and the heading of the F-100F was 145 degrees magnetic. This heading for the F-100F seems reasonable because the aircraft was to the right of the desired 170-degree track and a normal correction to track procedure required a heading of 140 degrees. Because of its position, right of track, it would seem probable that the flight approached KRAM from the basic instrument practice area located east of the facility. Because of unknown factors, any estimate of the amount of turn required to the outbound heading cannot be determined or reasonably estimated.

The swath cut through the DC-7 wing by the F-100F wing was approximately two feet wide and the edges were nearly perpendicular to the plane of the DC-7 wing. For a wing eight inches thick and swept more than 45 degrees at the leading edge to have cut a 24-inch vertical swath through the DC-7 wing it would have been necessary for the F-100F wing to have contacted the DC-7 wing at a considerable angle of attack relative to the collision course and for the aircraft to have been rolled beyond a 90-degree bank. Paint scrape marks on the bottom of the F-100F right wing showed that it was the bottom side of the F-100F wing which made the contact, indicating that the F-100F was banked to the left. The distance between the swaths cut by the F-100F wing and tail surface indicated that the aircraft was in approximately a 15-degree negative angle of attack attitude at the instant of collision. The F-100F was also in a 12-degree nose-down attitude relative to the DC-7. An approximate 4-degree angle of descent would have been normal during the penetration.

From the angles of bank, descent, and attack indicated, as well as eye-witness information obtained, it is the Board's view that a last second evasive maneuver was initiated by the F-100F instructor intending to avoid the DC-7 by diving to the left, down, and under the aircraft. The F-100F passed the nose of the DC-7, narrowly missing its No. 4 propeller. Then the aircraft collided in the attitudes described.

To the Board the 15-degree negative angle of attack seems extreme even under the circumstances. Because of this it is noteworthy that the angle would be reduced one degree for each degree that the DC-7 was yawed to its left. It would also be reduced by a greater speed than was estimated for the aircraft. Of the two possibilities, it is believed most likely that one of the pilots of the DC-7 saw the F-100F in the last seconds before collision and initiated a desperate evasive maneuver to avoid it.

Since the F-100F evasive maneuver was not initiated in time to be successful it can be assumed that the course of the F-100F was not altered appreciably during the maneuver. The two aircraft may then be backed apart from the point of collision for a reasonable distance along their courses at impact so that their relative locations to one another may be established and the possibilities of the pilots having sighted each other evaluated. The vector diagram indicates that the DC-7 was approaching the F-100F on a bearing 24 degrees to the right of the nose of the F-100F and it would have been at nearly eye level. This location falls directly behind the opaque canopy ring of the F-100F and, assuming no head movement, would make sighting the DC-7 at more than a mile nearly impossible and at more than one-half mile very difficult since at that distance the eyes of only one of the pilots would be in a position to see the DC-7 clearly.

The relative angle of approach of the F-100F to the DC-7 was from 34 degrees to the left and approximately 5 degrees above the horizon. This angle of approach falls behind the corner post between the captain's clear vision window and side window. The captain would have been able to see the F-100F approach with only one eye but if his head were two or three inches to the left of normal he could not have seen the aircraft at all until it was much too late to avoid the collision. The approach of the F-100F should have been unobscured to the copilot of the DC-7 through the captain's front windshield. The flight engineer on the DC-7 had no opportunity to observe the approach since his location in the cockpit was too high and too far aft to permit any upward visibility.

While the Board recognizes the difficulties involved in maintaining visual separations at high rates of closure as hereinbefore described, it must continue to provide for VFR operations in the Civil Air Regulations. Regulatory prohibition of VFR operations creates but one alternative—the exercise of positive control. The immediate implementation of full positive control would rule a very large percentage of essential traffic from the air. The reason is simply that the present air traffic control capacity is inadequate to handle so great a volume. On June 15, 1958, an important step was taken in the initiation of positive control; however, it will be several years before the major portion of the airspace will be accommodated. This goal will be attained by a gradual extension of positive control commensurate with the increase of air traffic control capability. The Board is now considering whether the advent of civil air carrier jets requires regulation making mandatory the use of positive control airspace and whether certain speed limitations will have to be applied in controlled airspace not subject to positive control.

In the interim period the Board will continue to apply the visual flight rules with whatever refinements the state of the art permits. In addition to the regulatory steps already mentioned which have been taken to enhance visual separation, the Board has other regulatory matters under consideration directed toward the same goal. Some of these are the use of standard altimeter settings, the use of fluorescent paint, a lowering of the floor of the Continental Control Area, the increase of visibility and distance from cloud requirements for high speed aircraft, and extension of speed control.

Conclusion

The accident, which appears to have occurred under the most adverse conditions contemplated under VFR insofar as the opportunity for the pilots to see and avoid is concerned, raises the question whether the long established visual flight rules are adequate in uncontrolled operations. It is clear that, under certain conditions of speed and angle of convergence, insufficient opportunity exists for pilots to observe other aircraft and take avoidance action. As aircraft speeds and traffic density increase, this problem will be aggravated. To this end the Board has promulgated regulations under which a positive control service has been initiated by the CAA on certain transcontinental routes between 17,000 and 22,000 feet. It is essential that positive control be extended to altitudes as high as 35,000 feet and on additional routes as rapidly as practicable. While the problem of aircraft speeds and traffic density is serious, and growing more so, it is not sufficient cause to discard the see and be seen rule in entirety. Alternatives to this fundamental rule in VFR operations either do not exist as yet or are so extreme that they would penalize the expeditious flow of traffic to the point where U. S. aviation in general would be stifled. The practical consequences of immediate implementation of full positive control for such operations regardless of weather would be the grounding of a great majority of current aircraft operations. Therefore, until technological advances are made which will ensure separation of aircraft without reliance on the vigilance of the pilot, the Board will continue to retain visual flight rules with whatever refinements circumstances and the state of the art permit. The necessity for this position has been agreed by all major users of the airspace, both civil and military.

From a review of the operating procedures used at Nellis and all the evidence and testimony obtained during the investigation, the Board views critically some of the procedures which relate to this accident. Generally, the policies and procedures indicate full cognizance of the collision hazards inherent in the particular training performed and equipment flown. Air Force Regulation 55-19 contains numerous provisions in this regard. Through establishment of the local flying area and mission subdivisions, arrival and departure corridors, scheduling and altitude requirements, an effective segregation of aircraft operations is facilitated in most of the training phases.

It is the Board's view, however, that in the instrument training phase and in particular the VFR practice KRAM penetrations, insufficient attention was given the segregation of military training operations from other users of the airway. It is apparent that simulated instrument approaches must be practiced and must utilize radio facilities which, in most cases, are located to form the airway structure. Nevertheless, penetration procedures intended for training maneuvers to be flown mostly in VFR weather conditions should be those which create the least collision exposure. The KRAM penetration selected in this case, however, required a flight course which was almost wholly on Victor Airway 8 where most air traffic could reasonably be expected. The Board is of the opinion that, when it was determined no outlying facility could be established or used as provided in AFR 55-19, it was incumbent upon the military to establish procedures providing minimum collision exposure according to the intent of this requirement. The KRAM penetration did not fulfill this obligation.

The Board is well aware of the importance of the military mission and there is no question as to the military right to use controlled airspace. Although such airspace is frequently described as "civil airways," except for portions specifically reserved, all airspace is open to all users, civil, and military. The Board requires that users must operate in accordance with the rules governing the airspace and expects such airspace to be used in a manner which takes fullest account of limitations of pilot capacity to maintain visual separation and which provide the best environment for visual separation.

In view of testimony of CAA witnesses, there is no doubt that the Administrator was cognizant of the extent and nature of the training activities at Nellis AFB. The penetration agreement was approved by personnel of CAA and it was known by the nature of the training mission that the procedures agreed upon would be used primarily during VFR weather conditions for training. The CAA was also fully aware that the procedures, of necessity, had been established on the navigational aids in the Las Vegas terminal area where several airways intersect and over which there is considerable traffic flow. Furthermore, the CAA was aware of the difficulty in maintaining visual separation created by the speed and rate of descent of the F-100 series aircraft.

The Board believes that the CAA exercised poor judgment in failing to take any action with respect to conditions that existed on the airway structure which impaired visual collision avoidance and created unnecessary collision exposure. When the CAA agreed that the penetrations were necessary to the Nellis Training Program and that they would be established in the Las Vegas terminal area, it was reasonable to expect that the CAA would have made certain that such procedures would create minimum conflict with other traffic on the airways when used as a VFR procedure. As hereinbefore pointed out, Section 60.46 of the

Civil Air Regulations is part of the instrument rules and therefore the CAA is not required by this regulation to consider VFR use of the penetration procedure as a factor for approval. However, the absence of such regulatory responsibility in this instance does not in our opinion excuse the Administrator for failing to take some action to reduce a known collision exposure in visual flight conditions.

Under Title III of the Civil Aeronautics Act the Administrator is directed, among other things, to encourage and foster the development of civil aeronautics and air commerce; to designate civil airways and to acquire, establish, operate and maintain air navigation facilities along such civil airways and at landing areas; and to make provision for the control and protection of air traffic moving in air commerce. The Administrator in performing these functions is directed by Section 2 of the Act to regulate air commerce "in such manner as to best promote its development and safety."

We do not feel this was done in this case. The record is clear that the Administrator was cognizant of the extent and nature of the training activities at Nellis Air Force Base and that the penetration procedures approved by him would be used primarily during VFR weather conditions for training. Yet, no action of any kind was taken by the Administrator, even after he had received complaints from United Air Lines. The record shows that the Administrator did not approach the Military in an effort to reach a voluntary agreement to alleviate the situation, nor was any attempt made to relocate the airway or to provide additional facilities for the jet penetration procedures. It was not until after the accident that a joint CAA-Military survey team was created to review Military activities throughout the country and to reexamine the jet penetration procedures used by Nellis Air Force Base. The Board recognizes the possibility that voluntary action by the Administrator might have met with resistance on the part of the Military. The fact remains, however, that no attempt at voluntary action was taken by the Administrator, nor did he advise the Board that he deemed himself powerless to act and therefore that regulatory action was required by the Board.

The Administrator, with his large staff of safety technicians stationed throughout the country, is familiar with all of the safety aspects of civil aviation as problems arise on the local level and therefore has a working knowledge of these problems on a day-to-day basis. The Board believes that where the Administrator is aware of the existence of a potentially unsafe situation in which he believes himself powerless to act, he should immediately bring this to the attention of the Board. The Administrator's statutory duty under Section 301 of the Act to "cooperate with the Board in the administration and enforcement of this Act" clearly requires him to bring such matters to the Board's attention. This was not done.

Many of the actions initiated by the CAA and operational procedures effected by Nellis following the accident could reasonably have been taken before it occurred. The record indicates that when United Air Lines reported "near misses" on the airways near Las Vegas there were conferences but no other indicated corrective measures. It is the Board's conclusion that the incidents showed the need for and should have furnished the impetus for some of the later steps. All of the actions, in essence, reduce the collision exposure, take greater cognizance of other users, and utilize as much IFR Air Traffic Control service as can be obtained.

The testimony of various witnesses indicated that United Air Lines was aware of the general flying activity from Nellis AFB. It was indicated that the company knew there was extensive flying training from the Base and that F-100 series aircraft were being used. It is also reasonable to assume that United knew that jet penetrations would be flown and this activity would normally involve some use of the established navigational aids. Nevertheless, the Board does not believe that from this information United should have suspected that the KRAM penetration with its unwarranted collision exposure would be selected and used regularly and frequently as a VFR training maneuver.

United had experienced numerous "near miss" incidents on the airway in the vicinity of Las Vegas. These, according to the United operations manager, were of major concern to United and were promptly reported to the CAA. The Board believes that United's action was proper and it was reasonable for the company to expect that appropriate corrective action would be taken by the CAA.

Probable Cause

The Board determines that the probable cause of this collision was a high rate of near head-on closure at high altitude; human and cockpit limitations; and the failure of Nellis Air Force Base and the Civil Aeronautics Administration to take every measure to reduce a known collision exposure.

BY THE CIVIL AERONAUTICS BOARD:

/s/ JAMES R. DURFEE

/s/ CHAN GURNEY

/s/ HARMAR D. DENNY

/s/ G. JOSEPH MINETTI

/s/ LOUIS J. HECTOR

S U P P L E M E N T A L D A T A

Investigation and Hearing

The Civil Aeronautics Board was notified of this accident through its Santa Monica office a few minutes after it occurred. Investigators were promptly dispatched to the scene and an investigation was initiated and conducted in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. A public hearing was ordered by the Board and held in the Fremont Hotel, Las Vegas, Nevada, June 16-18, 1958.

Air Carrier

United Air Lines, Inc., is a Delaware corporation with its corporate offices in Chicago, Illinois. The company is engaged in transporting by air persons, property, and mail. It holds a currently effective certificate of public convenience and necessity issued by the Civil Aeronautics Board and an air carrier operating certificate issued by the Civil Aeronautics Administration. These authorize operation over a number of routes including that from Los Angeles to New York.

United States Air Force

The headquarters of the United States Air Force is located in Washington, D. C. Nellis Air Force Base is located at Las Vegas, Nevada, and functions under the Air Training Command.

Flight Personnel

United Air Lines. Captain Duane Mason Ward was employed by United Air Lines as a first officer on February 20, 1940, and promoted to reserve captain on March 1, 1942. He flew as reserve captain until February 16, 1945, when he was assigned full time as captain and flew in that capacity until this accident. A review of company and CAA records indicates that Captain Ward had discharged his duties and responsibilities in a satisfactory manner. He received his last route check on March 30, 1958, and a CAA physical examination with no waivers on January 20, 1958. Captain Ward had flown a total of 15,790 hours, of which 450 were in the last six months. He was issued ATR certificate No. 94778 on March 23, 1942, and received a type rating on DC-6 equipment on July 23, 1947. He was 45 years of age.

First Officer Arlin E. Sommers, age 36, was employed by United Air Lines on February 13, 1951, as a student pilot and assigned to the line as first officer on March 22, 1951. He was issued ATR No. 393508 on September 8, 1953, and had flown a total of 8,448 hours, of which 453 were in the last six months. His last route check was conducted on March 30, 1958, and records indicate that all phases of check were completed satisfactorily. His last CAA physical examination was on May 7, 1957, and he had a company physical examination on March 26, 1958. There were no waivers or limitations on either.

Flight Engineer Charles E. Woods, age 44, was employed by United Air Lines on August 24, 1942, as apprentice mechanic. On April 1, 1950, he was transferred from senior line mechanic to flight engineer school, and on April 24, 1950, was issued flight engineer certificate No. 1180620. He completed DC-7 training on June 25, 1954, and had been assigned to this type equipment since that date,

accumulating a total of 7,200 hours. He also held private pilot certificate No. 1363535, a second-class radio license, RP 15-3899, restricted radio telephone license RP 1860964, and A&E mechanic certificate No. M-153841. His last CAA physical examination was completed on March 10, 1958, with no waivers or limitations.

Stewardess Yvonne M. Peterson, age 28, completed training and was assigned to the line as stewardess on August 11, 1954.

Stewardess Pauline M. Murray, age 23, completed the 4-1/2-week training course on November 14, 1957, and was assigned as stewardess to the line on that date.

USAF. Captain Tom N. Coryell, age 28, USAF, AO 2216622, received a rating as pilot on May 1, 1953, and since that time had acquired 1,542 hours pilot time. Of this, 216 hours were in F-100 type aircraft. Captain Coryell held an instrument rating Form 8-A (white), dated May 11, 1957, and last had a physical examination on May 9, 1957.

First Lieutenant Jerald D. Moran, age 23, was designated a pilot on October 15, 1957, and held an instrument rating Form 8-A (white), dated September 30, 1957. He had flown a total of 363 hours and had 12 hours, 40 minutes in F-100 aircraft. His last physical examination was dated February 4, 1958.

Air Force records showed both pilots were currently qualified for the mission being flown and for their respective Air Force duty assignment.

The Aircraft

The DC-7, N 6328C, was manufactured by Douglas Aircraft Company during December 1956, and was delivered to the carrier on January 15, 1957. It had a total time of 4,802 hours, of which 2,037 hours were since last overhaul. The aircraft was equipped with four Wright engines, model 972T 18DA-2, and Hamilton Standard propellers, model 34E60. N 6328C was properly certificated for air carrier operation and was maintained in an airworthy condition in accordance with a CAA-approved maintenance program.

The F-100F-5-NA, Air Force 56-3755, was manufactured and delivered to the USAF by North American Aviation on July 29, 1957. The total time on the aircraft was 184 hours, since new. The aircraft was powered by a Pratt and Whitney turbo jet engine, model J57-P-21A. The engine had accumulated a total time, since new, of 128 hours. The aircraft and engine had been properly maintained in an airworthy condition in accordance with Air Force requirements.